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II. *Monsieur Cassini his New and Exact Tables for the Eclipses of the First Satellite of Jupiter, reduced to the Julian Stile, and Meridian of London.*

**A**Mong the Books the Royal Academy of Sciences at Paris has lately gratified the World withal, there is one which has for Title, *Recueil d'Observations faites en plusieurs Voyages pour perfectionner l'Astronomie & la Geographie, Avec divers traitez Astronomiques*. In which those *Sçavans* have set a very commendable Example in ascertaining by undoubted Observations the true *Geographical Site* of all the Principal Ports of *France*, which it were to be wished other Nations would imitate. By this Survey they have demonstrated the Encroachments their *Geographers*, and particularly *Sanfon*, had made on the *Sea* to enlarge their *Kingdom*, and have retrenched more of their *Usurpations* on the *West, South, and North*, than all their *Acquists* on the *East* amount to twice told.

The Method they have used to determine the *Longitudes* of their Places, is by the Observation of the *Eclipses* of the *First Satellite* of *Jupiter*, which they find almost instantaneous, and with good Telescopes discernable almost to the very Opposition of *Jupiter* to the *Sun*: And it may be said, that this Account of the *Longitudes* observed, has put it past doubt that this is the very best way, could portable Telescopes suffice for the Work. And could these *Satellites* be observed at *Sea*, a *Ship* at *Sea* might be enabled to find the Meridian she was in, by help of the Tables Monsieur *Cassini* has given us in this Volume, discovering with very great exactness the said *Eclipses*, beyond what we can yet hope to do by the *Moon*, tho' she seem to afford us the only means Practicable for the *Seaman*. However before Saylor's can make use of the Art of finding the *Longitude*, it will be requisite that the Coast of the whole Ocean be first laid down truly, for which work this Method by the *Satellites* is most apposite: And it may be hoped that either the true Geometrick Theory of the *Moon* may be discovered, by the time the Charts are

completed; or else that some Invention of shorter Telescopes manageable on Ship-board, may suffice to shew the *Eclipses* of the *Satellites* at Sea, at least those of the Third *Satellite*, which fall at a good distance from the Body of *Jupiter*, being near three times as far from him as the first.

The last but most considerable Treatise of this Collection gives the aforesaid Tables for computing the Motions of *Jupiter's Satellites*, but more especially those, for speedy finding the *Eclipses* of the first or innermost. Wherein Monsieur *Cassini* has employed his Skill to make easie and obvious to all Capacities the Calculation of them, which is otherwise operose to the Skilful, and not to be undertaken by the less knowing, who yet perhaps would be willing to find the Longitude of the Places they live in.

These Tables have for Principles, That the innermost *Satellite* revolves to the Sun in  $1^d. 18^h. 28'. 36''$ . so precisely, that in 100 Years the difference is not sensible; That in the time of the Revolution of *Jupiter* to his *Aphelion*, which he supposes in  $4332^d. 14^h. 52'. 48''$ , this *Satellite* makes exactly 2448 Months or Revolutions to the Sun: and dividing the Orbit of *Jupiter* into 2448 parts, he has in a large Table of *Æquation* shewn what is the inequality of the Motion of *Jupiter* in each Revolution reduced to Time, assuming *Thirdly*, the greatest *Æquation* of *Jupiter*  $5^o. 30'$ . whence the hourly Motion of the *Satellite* from *Jupiter* being  $8^o. 26' \frac{1}{4}$ , it follows, that the greatest inequality (*Jupiter* passing the Signs of *Cancer* and *Capricorn*,) amounts to  $39'. 8''$ . of time, to be added in *Cancer*, subtracted in *Capricorn*. Lastly, As to the *Epocha* or beginning of this Series of Revolutions, he has determined the *Aphelion* of *Jupiter* about  $1 \frac{1}{2}$  Degree forwarder than *Astronomia Carolina*, and above 2 Degrees more than the *Rudolphine Tables*, viz. precisely in  $9^o$  of *Libra*, in the beginning of this Century, which perhaps he finds the proper Motion of *Jupiter* about the Sun at this time to require; and the number of Revolutions since *Jupiter* was last in *Perihelion*, is here stiled *Num. I.*

A second Inequality is that which depends on the distance of the Sun from *Jupiter*, which he says Monsieur *Romer* did most ingeniously explain by the Hypothesis of the Motion of Light; to which yet *Cassini* by his manner of *Calculus* seems not to assent, though it be hard to imagine how the Earth's Position in respect of *Jupiter* should any way affect the Motion of the *Satellites*. This Inequality he makes to amount to two Degrees in the *Satellites* Motion, or  $14^{\circ} 10''$ . of Time, wherein he supposes the Eclipses to happen so much sooner when *Jupiter* Opposes the Sun; than when he is in Conjunction with him. The distribution of this Inequality he makes wholly to depend on the Angle at the Sun between the Earth and *Jupiter*, without any regard to the Excentricity of *Jupiter*, (who is sometimes  $\frac{1}{2}$  a Semidiameter of the Earth's Orb farther from the Sun than at other times) which would occasion a much greater difference than the Inequality of *Jupiter* and the Earth's Motion, both of which are accounted for in these Tables with great Skill and Address. But what is most strange, he affirms that the same Inequality of two Degrees in the Motion, is likewise found in the other *Satellites*, requiring a much greater time, as above two Hours in the fourth *Satellite*: which if it appeared by Observation, would overthrow Monsieur *Romer*'s Hypothesis entirely. Yet I doubt not herein to make it demonstratively plain, that the Hypothesis of the progressive Motion of Light is found in all the other *Satellites* of *Jupiter* to be necessary, and that it is the same in all; there being nothing near so great an Annual Inequality as Monsieur *Cassini* supposes in their Motions, by his Table, pag. 9. and his *Præcepta Calculi*. The Method however used to compute this is very Curious; for having found that whilst the Sun revolves to *Jupiter*, there pass  $398^{\text{d}} 21^{\text{h}} 13'$ . wherein are made  $225 \frac{1}{2}$  Revolutions of the *Satellite* to *Jupiter*, the Number of Revolutions since *Jupiter* was last in Opposition to the Sun, is what he calls Num. II. in which the Inequality of the Earth's Motion is allowed for in the Months, and that of *Jupiter*'s Orb by a Table of the Equation of Num. II. amounting in all to  $3 \frac{1}{2}$  Revolutions of the *Satellite* to *Jupiter*. This in the Tables following I have thought fit to leave out, shewing how to find it by help of the former Equation of Num. I. The Numbers are in effect the same with Monsieur *Cassini*'s, only reduced to our Style and Meridian, and the form of them abridged, and as hoped amended.

See Philos. Transact. N<sup>o</sup>. 136.

*Epochæ Revolutionum primi Satellitis ad Jovis Umbra  
sub Meridiano Londinensi.*

Anno Jul. Curr.	D. h. / "	Num. I.	Num. II.	Anno Jul. Curr.	D. h. / "	Num. I.	Num. II.
1660	0 11 5 48	968	200,6	1690	0 16 8 24	2263	81,0
61	0 1 17 24	1174	181,2	91	0 6 20 0	21	61,6
62	1 9 57 36	1381	162,9	92	0 15 0 12	228	43,3
63	1 0 9 12	1587	143,5	93	0 5 11 48	434	23,9
1664	1 8 49 24	1794	125,1	94	1 13 52 0	641	5,5
65	0 23 1 0	2000	105,7	1695	1 4 3 36	847	211,5
66	0 13 12 36	2206	86,4	96	1 12 43 48	1054	193,1
67	0 3 24 12	2412	67,0	97	1 2 55 24	1260	173,7
68	0 12 4 24	171	48,6	98	0 17 7 0	1466	154,4
1669	0 2 16 0	377	29,2	99	0 7 18 36	1672	135,0
70	1 10 56 12	584	10,9	1700	0 15 58 48	1879	116,6
71	1 1 7 48	790	216,9	01	0 6 10 24	2085	97,3
72	1 9 48 0	997	198,5	02	1 14 50 36	2292	78,9
73	0 23 59 36	1203	179,1	03	1 5 2 12	50	59,5
1674	0 14 11 12	1409	159,7	04	1 13 42 24	257	41,1
75	0 4 22 48	1615	140,3	1705	1 3 54 0	463	21,8
76	0 13 3 0	1822	121,9	06	0 18 5 36	669	2,4
77	0 3 14 36	2028	102,5	07	0 8 17 12	875	208,4
78	1 11 54 48	2235	84,1	08	0 16 57 24	1082	190,0
1679	1 2 6 24	2441	64,7	09	0 7 9 0	1288	170,6
80	1 10 46 36	200	46,4	1710	1 15 49 12	1495	152,3
81	1 0 58 12	406	27,0	11	1 6 0 48	1701	132,9
82	0 15 9 48	612	7,6	12	1 14 41 0	1908	114,5
83	0 5 21 24	818	213,6	13	1 4 52 36	2114	95,1
1684	0 14 1 36	1025	195,3	14	0 19 4 12	2320	75,8
85	0 4 13 12	1231	175,9	1715	0 9 15 48	78	56,4
86	1 12 53 24	1438	157,5	16	0 17 56 0	285	38,0
87	1 3 5 0	1644	138,1	17	0 8 7 36	491	18,6
88	1 11 45 12	1851	119,7	18	1 16 47 48	698	0,3
1689	1 1 56 48	2057	100,4	19	1 6 59 24	904	206,3
				1720	1 15 39 36	1111	187,9

**Tabula Revolutionum primi Satellitis Jovis in Anno.**

<i>Januarius.</i>				Num. I.	Num. II.	<i>Februarius.</i>				Num. I.	Num. II.
D.	h.	'	"			D.	h.	'	"		
0	0	0	0	0	0,0	13	5	55	0	25	25,7
1	18	28	36	1	1,0	15	0	23	36	26	26,7
3	12	57	12	2	2,1	16	18	52	12	27	27,7
5	7	25	48	3	3,1	18	13	20	48	28	28,7
7	1	54	24	4	4,1	20	7	49	24	29	29,7
8	20	23	0	5	5,2	22	2	18	0	30	30,8
10	14	51	36	6	6,2	23	20	46	36	31	31,8
12	9	20	12	7	7,2	25	15	15	12	32	32,8
14	3	48	48	8	8,2	27	9	43	48	33	33,8
15	22	17	24	9	9,3	<i>Martius.</i>					
17	16	46	0	10	10,3	1	4	12	24	34	34,8
19	11	14	36	11	11,3	2	22	41	0	35	35,8
21	5	43	12	12	12,3	4	17	9	36	36	36,8
23	0	11	48	13	13,4	6	11	38	12	37	37,9
24	18	40	24	14	14,4	8	6	6	48	38	38,9
26	13	9	0	15	15,4	10	0	35	24	39	39,9
28	7	37	36	16	16,5	11	19	4	0	40	40,9
30	2	6	12	17	17,5	13	13	32	36	41	41,9
31	20	34	48	18	18,5	15	8	1	12	42	42,9
<i>Februarius.</i>						17	2	29	48	43	43,9
0	20	34	48	18	18,5	18	20	58	24	44	44,9
2	15	3	24	19	19,6	20	15	27	0	45	45,9
4	9	32	0	20	20,6	22	9	55	36	46	46,9
6	4	0	36	21	21,6	24	4	24	12	47	47,9
7	22	29	12	22	22,6	25	22	52	48	48	48,9
9	16	57	48	23	23,7	27	17	21	24	49	49,9
11	11	26	24	24	24,7	29	11	50	0	50	50,9
13	5	55	0	25	25,7	31	6	18	36	51	51,9

*Aprilis.*

*Tabula Revolutionum primi Satellitis Jovis in Anno.*

<i>Aprilis.</i>				Num. I.	Num. II.	<i>Maius.</i>				Num. I.	Num. II.
D.	h.	'	"			D.	h.	'	"		
0	6	18	36	51	51,9	14	12	13	36	76	76,4
2	0	47	12	52	52,9	16	6	42	12	77	77,4
3	19	15	48	53	53,9	18	1	10	48	78	78,4
5	13	44	24	54	54,9	19	19	39	24	79	79,3
7	8	13	0	55	55,9	21	14	8	0	80	80,3
9	2	41	36	56	56,9	23	8	36	36	81	81,3
10	21	10	12	57	57,9	25	3	5	12	82	82,3
12	15	38	48	58	58,9	26	21	33	18	83	83,3
14	10	7	24	59	59,9	28	16	2	24	84	84,2
16	4	36	0	60	60,8	30	10	31	0	85	85,2
17	23	4	36	61	61,8	<i>Junius.</i>					
19	17	33	12	62	62,8	1	4	59	36	86	86,1
21	12	1	48	63	63,8	2	23	28	12	87	87,1
23	6	30	24	64	64,8	4	17	56	48	88	88,0
25	0	59	0	65	65,7	6	12	25	24	89	89,0
26	19	27	36	66	66,7	8	6	54	0	90	90,0
28	13	56	12	67	67,7	10	1	22	36	91	90,9
30	8	24	48	68	68,6	11	19	51	12	92	91,9
<i>Maius.</i>						13	14	19	48	93	92,9
0	8	24	48	68	68,6	15	8	48	24	94	93,8
2	2	53	24	69	69,6	17	3	17	0	95	94,8
3	21	22	0	70	70,6	18	21	45	36	96	95,7
5	15	50	36	71	71,6	20	16	14	12	97	96,7
7	10	19	12	72	72,5	22	10	42	48	98	97,7
9	4	47	48	73	73,5	24	5	11	24	99	98,6
10	23	16	24	74	74,5	25	23	40	0	100	99,6
12	17	45	0	75	75,5	27	18	8	36	101	100,6
14	12	13	36	76	76,4	29	12	37	12	102	101,5

*Julius.*

*Tabula Revolutionum primi Satellitis Jovis in Anno.*

<i>Julius.</i>				Num. I.	Num. II.	<i>Augustus.</i>				Num. I.	Num. II.
D.	h.	'	"			D.	h.	'	"		
1	7	5	48	103	102,5	14	13	0	48	128	126,8
3	1	34	24	104	103,5	16	7	29	24	129	127,7
4	20	3	0	105	104,4	18	1	58	0	130	128,7
6	14	31	36	106	105,4	19	20	26	36	131	129,7
8	9	0	12	107	106,4	21	14	55	12	132	130,7
10	3	28	48	108	107,3	23	9	23	48	133	131,7
11	21	57	24	109	108,3	25	3	52	24	134	132,7
13	16	26	0	110	109,3	26	22	21	0	135	133,6
15	10	54	36	111	110,2	28	16	49	36	136	134,6
17	5	23	12	112	111,2	30	11	18	12	137	135,6
18	23	51	48	113	112,2	<i>September.</i>					
20	18	20	24	114	113,1	1	5	46	48	138	136,6
22	12	49	0	115	114,1	3	0	15	24	139	137,6
24	7	17	36	116	115,1	4	18	44	0	140	138,6
26	1	46	12	117	116,0	6	13	12	36	141	139,6
27	20	14	48	118	117,0	8	7	41	12	142	140,6
29	14	43	24	119	118,0	10	2	9	48	143	141,5
31	9	12	0	120	119,0	11	20	38	24	144	142,5
<i>Augustus.</i>						13	15	7	0	145	143,5
0	9	12	0	120	119,0	15	9	35	36	146	144,5
2	3	40	36	121	119,9	17	4	4	12	147	145,5
3	22	9	12	122	120,9	18	22	32	48	148	146,5
5	16	37	48	123	121,9	20	17	1	24	149	147,5
7	11	6	24	124	122,9	22	11	30	0	150	148,5
9	5	35	0	125	123,9	24	5	58	36	151	149,5
11	0	3	36	126	124,9	26	0	27	12	152	150,5
12	18	32	12	127	125,9	27	18	55	48	153	151,5
14	13	0	48	128	126,9	29	13	24	24	154	152,5



*Tabula Revolutionum primi Satellitis Jovis in Anno.*

<i>October.</i>				Num. I.	Num. II.	<i>November.</i>				Num. I.	Num. II.
D.	h.	'	"			D.	h.	'	"		
1	7	53	0	155	153,5	16	8	16	36	181	180,0
3	2	21	36	156	154,5	18	2	45	12	182	181,0
4	20	50	12	157	155,5	19	21	13	48	183	182,0
6	15	18	48	158	156,5	21	15	42	24	184	183,0
8	9	47	24	159	157,5	23	10	11	0	185	184,0
10	4	16	0	160	158,5	25	4	39	36	186	185,1
11	22	44	36	161	159,5	26	23	8	12	187	186,1
13	17	13	12	162	160,5	28	17	36	48	188	187,2
15	11	41	48	163	161,6	30	12	5	24	189	188,2
17	6	10	24	164	162,6	<i>December.</i>					
19	0	39	0	165	163,6	0	12	5	24	189	188,2
20	19	7	36	166	164,6	2	6	34	0	190	189,2
22	13	36	12	167	165,6	4	1	2	36	191	190,3
24	8	4	48	168	166,6	5	19	31	12	192	191,3
26	2	33	24	169	167,7	7	13	59	48	193	192,3
27	21	2	0	170	168,7	9	8	28	24	194	193,4
29	15	30	36	171	169,7	11	2	57	0	195	194,4
31	9	59	12	172	170,7	12	21	25	36	196	195,5
<i>November.</i>						14	15	54	12	197	196,5
0	9	59	12	172	170,7	16	10	22	48	198	197,6
2	4	27	48	173	171,8	18	4	51	24	199	198,6
3	22	56	24	174	172,8	19	23	20	0	200	199,7
5	17	25	0	175	173,8	21	17	48	36	201	200,7
7	11	53	36	176	174,8	23	12	17	12	202	201,8
9	6	22	12	177	175,9	25	6	45	48	203	202,8
11	0	50	48	178	176,9	27	1	14	24	204	203,9
12	19	19	24	179	177,9	28	19	43	0	205	204,9
14	13	48	0	180	178,9	30	14	11	36	206	206,0
16	8	16	36	181	180,0						

Num.

*Tabula Primæ Equationis Conjunctionum primæ  
Satellitæ cum Jove.*

Num. I.	Equat.	Num. I.	Equat.	Num. I.	Equat.	Num. I.	Equat.
0	0 0	300	28 9	610	39 5	920	26 37
10	1 3	310	28 54	620	39 3	930	25 53
20	2 5	320	29 35	630	38 58	940	25 8
30	3 8	330	30 11	640	38 51	950	24 23
40	4 12	340	30 45	650	38 44	960	23 37
50	5 15	350	31 28	660	38 34	970	22 50
60	6 16	360	32 10	670	38 24	980	22 3
70	7 19	370	32 44	680	38 10	990	21 15
80	8 20	380	33 15	690	37 56	1000	20 26
90	9 23	390	33 49	700	37 40	1010	19 37
100	10 25	400	34 20	710	37 24	1020	18 47
110	11 25	410	34 51	720	37 5	1030	17 56
120	12 25	420	35 21	730	36 45	1040	17 5
130	13 25	430	35 47	740	36 25	1050	16 13
140	14 25	440	36 6	750	36 4	1060	15 19
150	15 22	450	36 26	760	35 40	1070	14 25
160	16 18	460	36 47	770	35 15	1080	13 32
170	17 17	470	37 8	780	34 49	1090	12 37
180	18 11	480	37 29	790	34 19	1100	11 42
190	19 9	490	37 44	800	33 49	1110	10 47
200	20 5	500	37 59	810	33 21	1120	9 52
210	20 56	510	38 16	820	32 50	1130	8 57
220	21 49	520	38 29	830	32 17	1140	8 0
230	22 41	530	38 39	840	31 44	1150	7 3
240	23 32	540	38 49	850	31 10	1160	6 7
250	24 20	550	38 55	860	30 32	1170	5 10
260	25 7	560	38 59	870	29 56	1180	4 13
270	25 57	570	39 3	880	29 19	1190	3 15
280	26 43	580	39 6	890	28 40	1200	2 19
290	27 27	590	39 8	900	27 59	1210	1 21
300	28 9	600	39 7	910	27 19	1220	0 24
		610	39 5	920	26 37	1224	0 0

*Tabula Secunda Equationis Conjunctionum primi  
Satellitis cum Jove.*

Num. II.	Equat. add.	Num. II.	Equat. add.	Num. II.	Equat. add.	Num. II.	Equat. add.
0	0' 0''	28	2' 4''	56	7' 0''	84	12' 0''
1	0 0	29	2 13	57	7 12	85	12 9
2	0 1	30	2 21	58	7 24	86	12 16
3	0 2	31	2 30	59	7 36	87	12 24
4	0 3	32	2 39	60	7 47	88	12 32
5	0 4	33	2 48	61	7 59	89	12 40
6	0 6	34	2 58	62	8 11	90	12 47
7	0 8	35	3 8	63	8 22	91	12 53
8	0 10	36	3 17	64	8 34	92	13 0
9	0 14	37	3 27	65	8 46	93	13 6
10	0 17	38	3 37	66	8 57	94	13 13
11	0 20	39	3 48	67	9 8	95	13 19
12	0 23	40	3 59	68	9 20	96	13 24
13	0 27	41	4 9	69	9 32	97	13 30
14	0 32	42	4 20	70	9 44	98	13 35
15	0 37	43	4 31	71	9 54	99	13 39
16	0 42	44	4 41	72	10 3	100	13 45
17	0 47	45	4 53	73	10 14	101	13 48
18	0 53	46	5 4	74	10 25	102	13 51
19	0 58	47	5 15	75	10 35	103	13 54
20	1 4	48	5 27	76	10 45	104	13 57
21	1 11	49	5 39	77	10 55	105	14 0
22	1 18	50	5 50	78	11 5	106	14 3
23	1 25	51	6 2	79	11 15	107	14 5
24	1 32	52	6 14	80	11 25	108	14 7
25	1 40	53	6 25	81	11 34	109	14 8
26	1 47	54	6 37	82	11 43	110	14 9
27	1 56	55	6 49	83	11 52	111	14 10
28	2 4	56	7 0	84	12 0	112	14 10

*Tabula Dimidiæ Moræ primi Satellitis in Umbra  
Jovis.*

Num.I.	H. ' "	Num.I.	H. ' "
0	1 4 56	1200	1 5 6
40	1 4 33	1240	1 4 48
80	1 4 12	1280	1 4 26
120	1 3 59	1320	1 4 7
160	1 3 48	1360	1 3 54
200	1 3 39	1400	1 3 38
240	1 3 38	1440	1 3 38
280	1 3 48	1480	1 3 44
320	1 4 1	1520	1 3 52
360	1 4 16	1560	1 4 7
400	1 4 36	1600	1 4 24
440	1 4 56	1640	1 4 42
480	1 5 18	1680	1 5 0
520	1 5 41	1720	1 5 22
560	1 6 1	1760	1 5 46
600	1 6 21	1800	1 6 10
640	1 6 39	1840	1 6 28
680	1 6 53	1880	1 6 45
720	1 7 3	1920	1 6 57
760	1 7 11	1960	1 7 7
800	1 7 15	2000	1 7 13
840	1 7 13	2040	1 7 14
880	1 7 9	2080	1 7 15
920	1 7 2	2120	1 7 15
960	1 6 54	2160	1 7 10
1000	1 6 39	2200	1 6 49
1040	1 6 22	2240	1 6 32
1080	1 6 5	2280	1 6 15
1120	1 5 45	2320	1 5 58
1160	1 5 26	2360	1 5 38
1200	1 5 6	2400	1 5 18
		2440	1 5 2

# TABULA ÆQUATIONIS DIERUM

*cum Solis loco adeunda.*

G.	γ S "		δ A "		II A "		♄ S "		♅ S "		♆ S "	
0	7	45	1	11	4	3	0	59	5	43	2	8
1	7	26	1	24	4	0	1	15	5	45	1	53
2	7	7	1	37	3	56	1	29	5	46	1	37
3	6	48	1	49	3	51	1	42	5	47	1	21
4	6	29	2	1	3	45	1	54	5	48	1	5
5	6	10	2	12	3	39	2	6	5	48	0	48
6	5	51	2	23	3	32	2	19	5	48	0	30
7	5	31	2	33	3	25	2	32	5	46	0	12
8	5	11	2	43	3	17	2	44	5	44	0 A	7
9	4	51	2	53	3	9	2	56	5	40	0	26
10	4	31	3	3	3	0	3	8	5	36	0	45
11	4	11	3	13	2	51	3	20	5	31	1	3
12	3	52	3	22	2	41	3	32	5	25	1	21
13	3	33	3	30	2	31	3	43	5	19	1	40
14	3	14	3	37	2	21	3	54	5	13	1	59
15	2	55	3	43	2	10	4	4	5	6	2	19
16	2	37	3	48	2	0	4	14	4	58	2	40
17	2	19	3	53	1	49	4	24	4	49	3	1
18	2	1	3	57	1	37	4	34	4	39	3	22
19	1	43	4	1	1	25	4	43	4	30	3	44
20	1	26	4	5	1	13	4	51	4	20	4	6
21	1	9	4	8	1	1	4	59	4	9	4	29
22	0	52	4	10	0	49	5	6	3	57	4	51
23	0	35	4	12	0	37	5	13	3	45	5	13
24	0	19	4	13	0	24	5	19	3	32	5	35
25	0	3	4	11	0	10	5	24	3	19	5	57
26	0 A	12	4	9	0 S	3	5	29	3	5	6	19
27	0	27	4	8	0	16	5	33	2	51	6	41
28	0	42	4	6	0	29	5	37	2	37	7	2
29	0	57	4	5	0	44	5	40	2	23	7	23
30	1	11	4	3	0	59	5	43	2	8	7	44

## TABULA EQUATIONIS DIERUM.

G.	<sup>♈</sup> A "	<sup>♉</sup> A "	<sup>♊</sup> A "	<sup>♋</sup> A "	<sup>♌</sup> S "	<sup>♍</sup> S "
0	7 44	15 34	13 25	0 59	11 48	14 36
1	8 5	15 42	13 7	0 27	12 4	14 29
2	8 25	15 48	12 48	0 S 5	12 19	14 21
3	8 45	15 53	12 29	0 35	12 35	14 13
4	9 5	15 57	12 10	1 4	12 50	14 4
5	9 25	16 1	11 50	1 33	13 5	13 55
6	9 44	16 5	11 30	2 3	13 19	13 46
7	10 3	16 7	11 10	2 32	13 32	13 37
8	10 22	16 8	10 49	3 1	13 44	13 27
9	10 41	16 9	10 28	3 29	13 55	13 17
10	11 0	16 9	10 6	3 57	14 5	13 7
11	11 19	16 9	9 42	4 25	14 14	12 56
12	11 38	16 8	9 17	4 53	14 22	12 44
13	11 57	16 7	8 51	5 20	14 29	12 32
14	12 15	19 5	8 25	5 48	14 35	12 19
15	12 33	16 1	7 58	6 15	14 40	12 6
16	12 50	15 56	7 31	6 42	14 45	11 52
17	13 7	15 50	7 5	7 9	14 50	11 37
18	13 22	15 44	6 38	7 34	14 54	11 21
19	13 36	15 37	6 12	7 58	14 56	11 4
20	13 49	15 30	5 45	8 21	14 58	10 46
21	14 2	15 22	5 19	8 45	14 59	10 28
22	14 14	15 13	4 52	9 8	15 0	10 10
23	14 26	15 3	4 26	9 31	15 0	9 52
24	14 37	14 52	3 58	9 53	15 0	9 34
25	14 47	14 40	3 30	10 13	14 58	9 16
26	14 57	14 27	3 1	10 32	14 55	8 58
27	15 7	14 13	2 31	10 51	14 51	8 40
28	15 16	13 58	2 1	11 10	14 47	8 22
29	15 25	13 42	1 30	11 29	14 42	8 4
30	15 34	13 25	0 59	11 48	14 36	7 45

This last Table of the *Æquation* of Natural Days might have been spared, as being publisht in several other places, but it was thought proper to have all the *Elements* of this *Calculus* together, that there might be no occasion of any other Book to perform it.

### *The Use of the Tables.*

*To any given Year, Month, and Day, to find the next Eclipse of the first Satellite of Jupiter.*

I. In the Table of *Epochæ* (pag. 240.) find the Year of our Lord, and set down the Day, Hours, Minutes, and Seconds, with the Num. I. and Num. II. thereto annex; and (in pag. 241 and the following) seek the Month, and day of the Month, with the Hours and Minutes, and Num. I. and II. affixt, and add them together: and the respective Sums shall shew the mean time of the middle of the Eclipse sought, with Num. I. and Num. II. required. But it must be observed, that in *January* and *February* in the Leap-Year one Day is to be added to the Day thus found.

II. If Num. I. be found less than 1224 with Num. I; or if greater than 2448, Substracting 2448 therefrom, with the residue, enter the Table, pag. 245. and you will have the first *Æquation* to be *added* to the mean Time before found. But if Num. I. be less than 2448, but greater than 1224, Substract it from 2448, and entring the same Table with the remainder, you shall have the first *Æquation* to be *subtracted* from the mean Time. Then Divide the Minutes of the said first *Æquation* by 11, or rather  $\frac{1}{7}$ , and the *Quote* shall be the *Æquation* of Num. II. (answering to the Eccentric Motion of *Jupiter*) to be *added* thereto when the first *Æquation* *Subtracts*, and *è contra* *subtracted* when that *adds*.

III. If Num. II. thus æquated exceed 225,4, Subtract 225,4 therefrom; and if the remainder or Num. II. be less than 113, with the said remainder or Number; or if greater than 113, with the complement thereof to 225,4. seek in Table pag. 246. the second *Æquation*, which being added to the Time before found, gives the true Time of the middle of the Eclipse.

IV. With Num. I. in *Tab. pag. 247*, seek the half Continuance of the Total Eclipse, which is to be added for the *Emerfion* when the æquated Num. II. is less than 113, or if more than 225,4, it be less than 338. But if it exceed 113 or 338, then is the *Semimora* to be subtracted for the *Immerfion*.

V. Lastly, with the Sun's true Place take out the *Æquation* of Natural Days (in *Tab. pag. 248.*) which added or subtracted according to the Title, gives the time of the *Immerfion* or *Emerfion* sought.

Now how few Figures serve for this Computation, will best appear by an Example or two.

Anno 1677. September 17<sup>th</sup> 8<sup>h</sup> 9'. 40". at *Greenwich*, Mr. *Flamsteed* observed the first *Satellite* to begin to *Emerge*; that is 8<sup>h</sup> 9'. 20". at *London*.

					Num. I.	Num. II.
1677.	0 <sup>d</sup> .	3 <sup>h</sup> .	14'	36"	2028	102,5
Sept.	17	4	4	12	147	145,5
Sept.	17	7	18	48	2175	248,0
Æquat. 1.	—		26	11	2448	2,3 +
	17	6	52	37	273	250,3
Æquat. 2.	+		1	39		225,4
Semimora	+	1	7	0		24,9
Equal Time	17	8	1	16	11)26,2(2,3+	
Æquation	+		9	25	0 in ≈ 5,00	
Appar. T.	17	8	10	41		
Obfer.		8	9	20		
Error	—		1	21		

Again,



Again, Anno 1683. November 30<sup>th</sup>. 16<sup>h</sup>. 48'. 40''  
under the Meridian of London, the Immersion of this  
Satellite was observed by E. Halley.

					Num. I.	Num. II.
1683.	0 <sup>d</sup> .	5 <sup>h</sup> .	21'	24''	818	213,6
Novemb.	30	12	5	24	189	188,2
Novemb.	30	17	26	48	1007	401,8
Æquat. 1.	+		19	52		1,8 —
Æquat. 2.	+		6	0	11)20(1,8—	400,0
Novemb.	30	17	52	40		225,4
Semimora	—	1	6	36		174,6
Temp.æquat.	30	16	46	4		50,8
Æquat. T.	+		6	3	☉ in ♄ 190. 20'	
Novemb.	30	16	52	7	Temp. appar.	
Obser.		16	48	40		
Error	—		3	27		

A Third Example shall be the *Emerfion* observed at  
Paris by Monsieur Cassini Anno 1693. January 14<sup>th</sup>. 10<sup>h</sup>.  
40'. 28''. that is, at London at 10<sup>h</sup>. 30'. 48''.

					Num. I.	Num. II.
1693.	0 <sup>d</sup> .	5 <sup>h</sup> .	11'	48''	434	23,9
Jan.	14	3	48	48	8	8,2
Æquat. 1.	+		36	8	442	32,1
Æquat. 2.	+		2	13		3,2 —
Semimora	+	1	4	57	11)36,(3,2—	28,9
Temp.æquat.	14	10	43	54		
Æquat.	—		13	15	☉ in ♄ 50. 40'.	
Januarii	14	10	30	39	Temp. app.	
Obser.		10	30	48		
Error	+		0	9		

After this manner I have compared these Tables with  
many good and certain Observations, and scarce ever  
find them err above three or four Minutes of Time;  
which proceeds, as may well be conjectured, from some  
small

small Eccentricity in its Motion, and from the Oval Figure of *Jupiter's* Body, whose quick diurnal Rotation has by its *Vis Centrifuga* dilated his Equinoctial, and made his *Meridians* much *Elliptical*, so as to be discernable by the Telescope. Mr. *Newton* has shewn that his Polar Diameter is to that of his Equinoctial as 40 to 41 nearly. But we may hope future Observations may shew how to divide those compounded causes of Error, and correct them; which Errors are exceeding small in comparison of the short time that the *Satellites* have been discovered, and argue the Skill and Diligence of the deservedly Famous Author of these *Tables*.

I had almost forgot the Construction of the Table, pag. 247. shewing the half continuance of these Eclipses: In this the Semidiameter of the shadow of *Jupiter* is made by *Cassini* just 10 Degrees, and that of the *Satellite* 30'; and the *Satellites* Ascending Node being supposed in 15° of *Aquarius*, at the end of this Century, (that is, 55° 20'. before the *Perihelion* of *Jupiter*) it will thence follow, that Num. I. being 816 or 2102, *Jupiter* passes the *Nodes* of the *Satellites* Orb, and consequently these Eclipses are Central, and of the greatest Duration. But Num. I. being 215 or 1481, the *Satellite* passes the shadow with the greatest Obliquity, viz. 2° 55' from the Center, whence the *Semimora* becomes of all the shortest. This Table is not however so nicely computed, but that it may admit of Correction in the Seconds, if a small part of a Minute were considerable in this affair.

The Tables of the other *three Satellites* not being so perfect or exact as those of the *first*, having greater inequalities, are here given in another form, requiring the assistance of the Tables of *Jupiter's* proper motion. The Periods of their Revolutions to *Jupiter's* shade are as follows:

Period. Secundi.	3 <sup>d</sup> .	13 <sup>h</sup> .	17 <sup>l</sup> .	54 <sup>''</sup> .	3 <sup>'''</sup>	five 2 $\frac{1}{123}$	Rev. primi.
Period. Tertii.	7	3	59	39	22	five 4 $\frac{1}{21}$	Rev. primi.
Period. Quartii.	16	18	5	6	50	five 9 $\frac{1}{17}$	Rev. primi.

Whence the Table of the first *Æquation* of the *First* *Satellite*, pag. 245, or Monsieur *Cassini*'s larger Table, may by an easie Reduction serve the other three; the *Æquation* of the *Second* being 2  $\frac{1}{123}$ , or twice the Minutes with half so many Seconds as there are Minutes in the *Æquation* of the *First*, and the greatest *Æquation* thereof 1<sup>h</sup> 18'. 35". The *Æquation* of the *Third* is 4  $\frac{1}{21}$  times greater than that of the *First*, and when greatest amounteth to 2<sup>h</sup> 38'. 29". And the *Æquation* of the *Fourth* being 9  $\frac{1}{17}$  times that of the *First*, is had by Subtracting  $\frac{1}{2}$  and  $\frac{1}{4}$  from ten times the *Æquation* of the *First*, whence the greatest becomes 6<sup>h</sup> 10'. 28". So that Num. I. and Num. II. as here collected for the *First*, may indifferently serve all the rest.

As to the Second *Æquation* of the other *Satellites*, Monsieur *Cassini* has, by his *Præcepta Calculi* (as is before mentioned) supposed the Minutes thereof to be increased in the same proportion; as instead of 14'. 10'' in the *First*, to be 28'. 27'' in the *Second*, 57'. 22'' in the *Third*, and no less than 2<sup>h</sup> 14'. 7'' in the *Fourth*; whereas if this second Inequality did proceed from the successive propagation of Light, this *Æquation* ought to be the same in all of them, which Monsieur *Cassini* says was wanting to be shewn, to perfect Monsieur *Romer*'s Demonstration; wherefore he has rejected it as ill founded. But there is good cause to believe that his motive thereto, is what he has thought not proper to discover. And the following Observations do sufficiently supply the Defect complained of in the making out of that Hypothesis.

Anno 1676. Octob. 2. Stil. Nov. 6<sup>h</sup> 10'. 37''. app. but 5<sup>h</sup> 59'. 37''. æq. time, Monsieur *Cassini* at Paris observed the *Emersion* of the *Third* *Satellite* from *Jupiter*'s shadow.

shadow. And again, *Novemb.* 14 following,  $6^h.20'.55''$ . app. Time, but  $6^h.5'.55''$ . æq. T. he observed the like *Emerfion* of the same *Satellite*. The observed Interval of Time between these *Emerfions* was  $43^d.0^h.6'.18''$  which is  $8'.22''$ . more than 6 mean Revolutions of this *Satellite*, of which  $4'.27''$ . arises from the difference of the first *Æquations* and the greater continuance of the latter Eclipse; so that the other 4 Minutes is all that is left to answer for the difference of the second *Æquations*; and Num. II. in that time increasing from 48 to 72, gives  $4'.36''$ . for the difference of the second *Æquations* of the *First Satellite*. So that here the second *Æquation* of the *Third* is found rather less than that of the *First*, but the difference is so small, that it may rather be attributed to the uncertainty of Observation. Whereas according to Monsieur *Cassini's* Method of Calculating, instead of four Minutes it ought to be  $18'.38''$ . and the Interval of these two *Emerfions*  $43^d.0^h.21'$ . exceeding the Time observed by a whole quarter of an hour; which that Curious Observer could not be deceived in.

The like appears yet more evidently in the *Fourth Satellite*. By the Observation of Mr. *Flamsteed* at *Greenwich*, Anno 1682. *Sept.* 24<sup>o</sup>.  $17^h.45'$ . T. app. but  $17^h.32'\frac{1}{2}$  T. æq. the *Fourth Satellite* was seen newly come out of the shadow, so that about  $17^h.30'$ . T. æq. the first beginning of *Emerfion* was conjectured; and after five Revolutions, viz. *Decemb.* 17<sup>d</sup>.  $11^h.16'$ . or  $11^h.18'$ . T. æq. he again observed the first appearance of the *Satellite* beginning to Emerge, that is, after an Interval of  $83^d.17^h.48'$ ; whereas this *Satellite* makes five mean Revolutions in  $83^d.18^h.25'\frac{1}{2}$ . Here we have  $37'\frac{1}{2}$  to be accounted for by the several Inequalities. Of this  $21'$  is due to the first *Æquations*, which is reduced to  $19'$  by the greater continuance of the latter Eclipse, *Jupiter* then approaching to his descending Node: So that there remains only  $18'\frac{1}{2}$  for the difference of the Second *Æqua-*

tions, whilst the *Earth* approached *Jupiter* by more than the *Radius* of its own *Orb*; and the difference of the second *Æquations* of the *First Satellite* being according to *Cassini*  $8^h. 30''$ , the said difference in the *Fourth* ought to be  $1^h. 20' \frac{1}{2}$  instead of  $18 \frac{1}{2}$ ; whence the Interval of these two *Emerfions* would be according to his Precepts, but  $83^d. 16^h. 46'$ , instead of  $83^d. 17^h. 48'$ . observed. And whereas  $18 \frac{1}{2}$  may seem too great a difference; it must be noted, first, that Monsieur *Romer* had stated the whole second *Æquation*  $22'. 00''$ , (*vide Phil. Transf. Num. 136.*) which Monsieur *Cassini* has diminished to  $14'. 10''$ ; so that instead of  $8 \frac{1}{2}$ , Monsieur *Romer* allows above  $13'$ ; and secondly, that in the first of these Observations, being about half an hour before Sun-rise, the brightness of the Morning might well hinder the seeing of this smallest and slowest *Satellite*, till such time as a good part thereof was emerged.

But I have exceeded the Bounds of my intended Discourse, and shall only Advertise, That these Tables are not Printed with the usual Care of the *Imprimerie Royale à Paris*, That the *Tabula Revolutionum primi Satellitis Jovis in Annis 100, pag. 13 & seq.* is faulty in these Years; 16, 39, 55, 98 & 99; as is also the *Epocha* for the Year 1700, *pag. 99.* where *pro Num. I. 1853 lege 1873*, and *pro Num. II. 1004, lege 1104*: And that the Number of Revolutions of the Second *Satellite* in 100 Years, *pag. 60, 61*; of the Third, *pag. 76, 77*; and of the Fourth, *pag. 90, 91*, are by a gross mistake of the Calculator, all false and erroneous, and must be amended by whosoever would use them. Which yet ought not in the least to be attributed to the Excellent Author, but rather to the Negligence of those employed by him. The Reader hereof is desired to amend these following *Errata*, which were discovered when it was too late.

ERRATA. *Pag. 238. lin. 24. pro*  $5^o. 30'. leg. 5^o. 31'. 40''$ . *lin. 25. pro*  $8^o. 26' \frac{1}{2}. leg. 8^o. 28' \frac{1}{2}$ .